

Closing the Loop for Medium Density Fibreboard

Elias, Robert; Bartlett, Craig

Proceedings of the Institution of Civil Engineers - Waste and Resource Management

DOI:

[10.1680/jwarm.17.00043](https://doi.org/10.1680/jwarm.17.00043)

Published: 24/05/2018

Peer reviewed version

[Cyswllt i'r cyhoeddiad / Link to publication](#)

Dyfyniad o'r fersiwn a gyhoeddwyd / Citation for published version (APA):

Elias, R., & Bartlett, C. (2018). Closing the Loop for Medium Density Fibreboard. *Proceedings of the Institution of Civil Engineers - Waste and Resource Management*, 171(2), 33-35.
<https://doi.org/10.1680/jwarm.17.00043>

Hawliau Cyffredinol / General rights

Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

- Users may download and print one copy of any publication from the public portal for the purpose of private study or research.
- You may not further distribute the material or use it for any profit-making activity or commercial gain
- You may freely distribute the URL identifying the publication in the public portal ?

Take down policy

If you believe that this document breaches copyright please contact us providing details, and we will remove access to the work immediately and investigate your claim.

Closing the Loop for Medium Density Fibreboard.

R.M. Elias and C. Bartlett

In 1966 the first Medium Density Fibreboard (MDF) mill was established in New York State. The Deposit mill had an initial capacity of 45,000m³ per year¹. Since then MDF production has increased year on year and can now be considered as a globally produced commodity product with 100M m³ manufactured every year.

Key to the expansion of MDF use is its versatility as a material with applications in the construction and furniture industries. MDF is made by processing wood chips that are softened using a combination of steam and heat in a pressurised refiner process that grinds the wood into wood fibres. An adhesive is added to the wood fibres in a spray process termed blowline blending after which the fibres are dried to a set moisture content. The dried resinated fibres are then formed into a mattress that is hot pressed. The hot presses use heat and pressure to cure the thermoset resin and form a panel of set density and thickness. Typical densities range from 700 kg/m³ to 760 kg/m³ and thicknesses range from 9mm to 18mm with some specialist thin and thick grades of higher or lower densities.

EU production has risen steadily and in 2016 the European Panel Products Federation reported a capacity of 14.7 million m³². Germany is the largest producer of MDF in the EU, followed by Poland, Italy, France, UK and Spain.

Key to the success of MDF is its machinability and ease with which decorative laminates can be readily applied to its surfaces. It is simple for users to achieve high quality finishes and intricate three dimensional designs, which has helped to increase consumption. Typical applications for MDF include kitchen units, internal window sills, moulded skirting boards, picture rails and a range of furniture items such as chairs, tables and shop fitting displays. Around 45 % of MDF is used in furniture, 32% used in laminate flooring with the remaining 23% used in construction, mouldings, panelling etc. Recent trends in the sector include the production of dimensionally stable products for moisture resistant grades and lighter weight panels for transport, construction and furniture applications.

But what happens to MDF when it comes to its end of life? Surprisingly for such a widely used material, none of it is currently recycled. This is in stark contrast to the particleboard industry, which was quick to adopt recycling in the 1990s³ as it offered a number of cost benefits for its production. Now the majority of particleboard production in the UK has an 80-90% recycled content with a mixture of recycled solid wood and old particleboard used in the furnish. A number of complex technical issues have thus far prevented similar approach for MDF production.

Recycling MDF is technically challenging due to the high density of the material, the adhesives used to glue the substrate fibres and the decorative laminate adhered to the surface. A number of technologies have looked at processes to separate the fibres, but none of these have led to commercial outcomes. Roffael, Behn and Schneider, 2017⁴ review these past attempts in their 2017

¹ The Leading Edge, the originating history of MDF in New Zealand, 2005. Piers Maclaren; New Zealand Institute of Forestry

² Annual Report 2016-2017. European Panel Federation, Brussels,

³ Earl and Elias, 1997. Technical Advantages of Utilising Recycled Wood in Particleboard Production. Proceedings of Wood, the Ecological Material, 4th Eurowood Symposium Trätek, Sweden.

⁴ E. Roffael, T. Behn; T. Schneider. 2017. Recycled Fibres from Waste Fibreboards as a Partial substitute of Virgin Fibres in MDF, Proceedings of the International Panel Products Symposium. Llandudno, Wales, UK.

paper that summarises the main approaches explored over the years. These included the batch process developed and patented by Chimar Hellas⁵ and published in 2003. This was scaled up to a pilot level and licenses offered but was not successful. The main reasons for lack of commercialisation were the high pressures and energy needed to breakdown the fibreboards. A similar process was developed by UK based Fibresolve Ltd, Riddiough 2002⁶, that was based on an autoclave process and utilised a mixture of chemicals to speed up the swelling process to liberate the fibres. However, plans to scale up the process failed.

At the same time the BioComposites Centre, part of Bangor University, teamed up with the UK's Furniture Industry Research Association (FIRA) and looked at developing a process to recycle waste MDF back into new MDF panels. The original project looked at the use of ultrasound, but the team found that this was not effective and discovered that heating MDF in a microwave was far more efficient and a GB patent was filed in 2004⁷.

The driver at that time was the high cost of waste disposal for the furniture industry. MDF was not recycled and in many cases was simply sent to landfill. Waste costs for some furniture companies were up to 10% of their turnover, so there was an incentive to look at recycling options. This project demonstrated that it was possible to recycle waste MDF back into 'new' MDF using microwave technology to reprocess the fibres; the key was continuous processing that did not damage the fibres.

A number of studies were published on the microwave process and a Life Cycle Assessment (LCA)⁸ was undertaken. This LCA sought to evaluate the environmental impacts associated with disposing of waste MDF in a number of different ways. The study looked at energy from waste (both onsite and offsite) and landfill compared with recycling the fibres back into MDF. The MDF manufacturer, Sonae Indústria at its Meppen plant in Germany, ran trials incorporating recovered MDF wood fibre within its production line. The resultant data obtained was used to model the process and determine the environmental effects of using recycled fibres as well as monitoring any impacts on production efficiency and product quality. These trials successfully demonstrated that an addition level of up to 20% recycled content could be achieved with no detrimental effects being noted. Work on the Microrelease project continued until around 2008 when commercial considerations stalled further development.

Since 2008 pressure on wood supplies has increased due to energy production. This has had a big impact on the supply of wood for panel production mills, including MDF. Alternative feedstocks were needed to help offset this impact but none really existed and this ongoing market failure highlighted the need for the development of a new process technology to recover value from waste MDF.

In 2009 MDF Recovery Ltd (MDFR) was established by Craig Bartlett to exploit this opportunity with subsequent R&D resulting in a patented alternative approach to the recovery of wood fibres from

⁵ Production of high added value products from wastes US 20030056873 A1

⁶ Riddiough, S., 2002. Wood Panel Recycling: An Introduction to the Fibresolve Process, Proceedings of the 6th European Panel Products Symposium, Llandudno, Wales, UK.

⁷ GB 2410 746. Recovering Components from Lignocellulose Board Materials.

⁸ A Life Cycle Assessment of Closed Loop MDF Recycling using the Microrelease Process to Produce Recycled Wood Fibre from MDF Waste 2009. WRAP

waste MDF. Although the economic crisis delayed the uptake of the MDR technology, there is now significant market pull in evidence.

Panel mills are facing increasing pressure on raw material prices and in some cases on security of long term supply of virgin timber.

Utilising recycled fibres will reduce manufacturing costs whilst also aligning with EU policy focussing on a drive towards the Circular Economy. The voluntary use of recycled feedstock may also avert the threat of Extended Producer Responsibility being thrust upon the sector. This topic was highlighted by EPF Chair Paolo Fantoni in his EPF Annual Report 2016-2017 where he called to the industry to be "Circular Economy Champions".

Having successfully completed a collaborative project funded by Innovate UK, MDR's technology has reached pilot scale and has been demonstrated to many of the largest European panel manufacturers. Investment from business angels and Suez Recycling and Recovery has assisted MDR to begin its commercialisation process. The design of a full scale plant is underway and, with a host corporate customer identified, the installation of the first commercial demonstration facility is expected in 2019.

MDR Recovery's Innovate UK project clearly demonstrated that fibres can be easily recycled saving money and energy and that closed loop recycling for MDF production was a realistic goal. The application of this technology within the MDF manufacturing sector is clear but the challenge now is to find additional markets where the technology may be exploited. There is strong evidence that the recovered fibres will be suitable for thermal insulation products, where natural materials can offer enhanced in-service performance over the more commonly used mineral wool offerings. Wood plastic composite applications are also being explored as is the horticulture market, which has historically been dominated by peat based products – no longer considered to be ethical in use.

Further opportunities have arisen to work with resin companies to develop new products. The ability to tailor bioresins or low emission adhesives for recycled fibres could lead to developing some highly innovative products. Tests have indicated that the recycled fibres have improved functional performance over virgin materials but this is yet to be optimised and fully understood. To get the maximum benefit, resin systems tailored to the recycled fibre may offer some key advantages. The lignin rich fibre surfaces have experienced a type of heat treatment that replicates the thermal process developed for increasing the durability of solid wood. These recycled MDF fibres may therefore be more durable and could be used to develop materials for high hazard applications. If this can be achieved there are many other future commercial opportunities for the panel product sector.

Dr Rob Elias
The BioComposite Centre
Bangor University
Tel 01248 388599
r.m.elias@bangor.ac.uk

Craig Bartlett
MDR Recovery Ltd
Tel+44 (0)1625 611706
Mob +44 (0)7803 607087
answers@mdrrecovery.co.uk